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BIOLOGICAL RESEARCH SECTION 1987 ANNUAL REPORT

Report No 88-124-K

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ABSTRACT

The structure and products of the Biological Research Section during 1987 are summarized. Progress on major areas of work is discussed and accomplishments listed. Plans for 1988 are also presented. Work will continue on utilization (thermal aquaculture), transmission systems (vegetation control), nuclear aspects (radionuclide studies, biofouling, biotechnology), and the environment (site surveys, fish control). Increased effort will be made to develop systems to automate fish control systems, to explore new environmental areas such as MISA, mercury pollution, and electromagnetic effects and to streamline site surveys.

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TO: Dr. D. Mills
Director of Research

BIOLOGICAL RESEARCH SECTION 1987 ANNUAL REPORT

1.0 INTRODUCTION

The Biological Research Section is responsible for carrying out a spectrum of biologically related work ranging from consulting through basic research in support of Ontario Hydro's planning and operational activities. An overview of the Section's major activities, accomplishments, concerns and plans for 1988 is provided here.

The Section's structure is a semi-matrix with one unit and three major program areas. A fourth program area is handled by Dr. G.L. Vascotto, a Senior Research Scientist. While his program is resourced through the Section, he reports, as the Section does, directly to the Manager.

In 1987, Mr. Gerry T. Haymes acted as Supervising Biologist from January through July and Dr. Fred Spencer acted in this capacity from August through September. Dr. Ann McMillan became Section Head in October.

Ms. Carol A. Thomson left the Section in 1987. Ms. Rosemarie Ayoung joined the Section in 1987.

The Section's programs are supported by external clients, corporate clients and divisional funds. A breakdown of 1986 and 1987 expenditures and those predicted for 1988 by the source of funds and program area is discussed later in this report.

The 1987 Biological Research Section work program was focused in four divisional program areas: Utilization, Transmission Systems, Nuclear Generation and Environment. The projects span the spectrum from generic research through site specific field studies to technology transfer funded by external clients. Reports issued during the year, publications and conference presentations are listed in the appendices.

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RESEARCH DIVISION

BIOLOGICAL RESEARCH

Ontario Hydro has developed diversified biological research capabilities in order to meet some of its planning and operating needs. The biological research group consists of more than 30 biologists, including 15 with advanced degrees and extensive research experience in industry, government and academic environments. The group enjoys the support of excellent field and laboratory research facilities and equipment. Although these capabilities were developed to meet Ontario Hydro's requirements, they are now available to industry and government agencies on a contract research basis.

CAPABILITIES

The capabilities of the biological research group are best illustrated by some of their major projects.

The staff have gained international recognition for their contribution to fish impingement research. This work includes a multi-year study on the responses of fish to behavioural cues in order to develop and test fish deterrent and guidance systems.

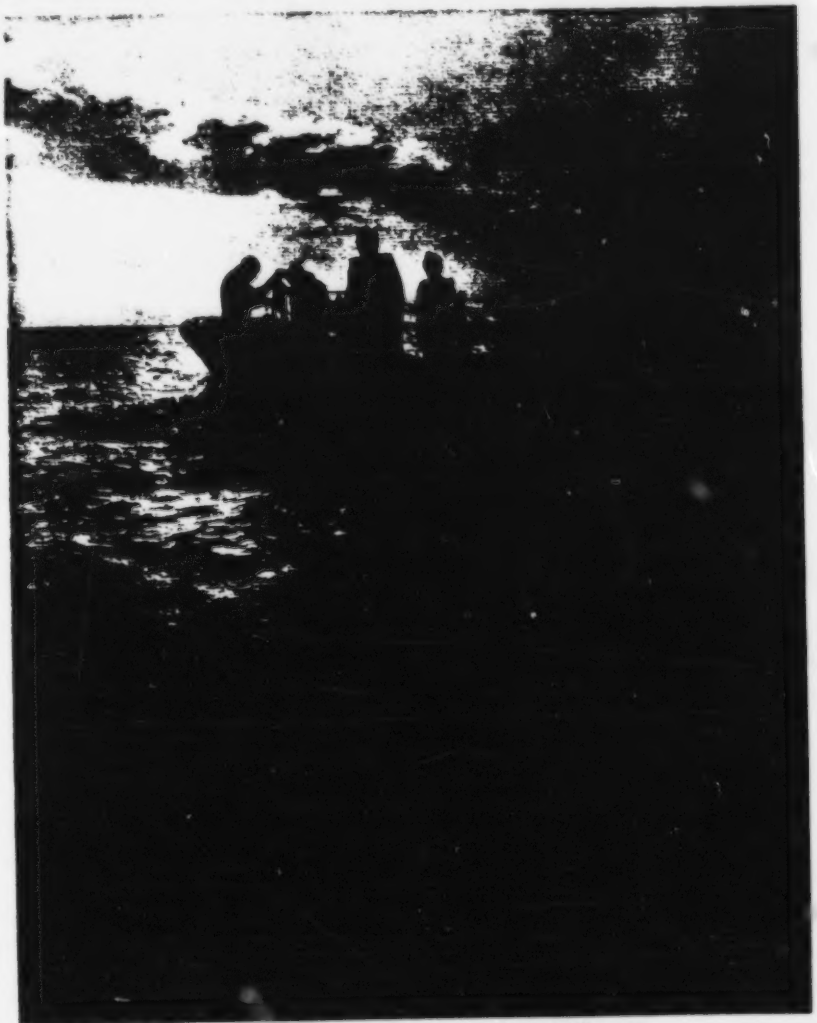
Uptake processes and subsequent movement of fission-emitted radionuclides in aquatic and terrestrial environments are also the subject of extensive studies.

The control of vegetation along rights of way, a topic of enduring interest to electrical utilities, is the subject of intensive study at the Ontario Hydro Research Division. The biology group is conducting combined laboratory-field studies of the impact of time-of-cutting on tree suckering; allelopathic effects of cover crops on tree germination; succession on herbicide-treated rights of way; and translocation of selected herbicides.

Impact-assessment studies, anticipated to last six to eight years, are being performed to evaluate the effects of generating facilities on the environments of Lake Ontario, Lake Huron and small inland lakes. For specific sites on the Great Lakes, over ten years of continuous historical ecological data are readily retrievable for cross-referencing and historical analysis. This is one of the most complete data bases for the nearshore area of the Great Lakes.

The group is also engaged in continuing research on the roles of watershed characteristics and soil microflora in the acid-sensitivity of lakes.

Biofouling is a topic of interest to many industries. The role of microorganisms in the fouling of heat ex-



Aquatic biologists setting out on environmental survey.

Leg banding provides statistics for estimating success of gull colonies near Ontario Hydro generating stations.

changers and condensers, and the development of early warning systems and mitigating techniques, are areas in which our biological research group has extensive experience.

RESOURCES

Field Studies: Experienced, well-equipped field research teams can be rapidly mobilized for either aquatic or terrestrial studies. Research vessels ranging from 14-ft runabouts to a 42-ft all-season boat are available for aquatic work, while on land mobile research laboratories can be moved to field sites for sample processing and preliminary analysis.

The biological research group has developed the most complete and sophisticated field structure in North America for fish-impingement studies in open water. This facility, located in Lake Ontario, permits testing of both mechanical and behavioural fish-deterrent systems in realistic open-water conditions. Fish behaviour in the impingement passages, each of which measures 18 ft by 30 ft, is monitored with underwater video and sidescan sonar or by use of nets.

In open-water studies, movements of individual fish are tracked by radio-telemetry. Fish behaviour can also be studied by underwater observation (all of our biologists have SCUBA certification). A digitized fish counting system is used in conjuction with conventional fishing techniques for accurate stock assessment and fish distribution studies.

Terrestrial studies requiring in-situ experimentation are carried out at a 25-acre parcel of mixed woodland and meadow. Tree stocks used in the studies are maintained at this site.

Laboratory Studies: Ontario Hydro has one of the best freshwater holding facilities and fish-behaviour laboratories in Canada, and one of two laboratories in Canada with the capacity for low-level radiobiological work on a large scale. Laboratories for environmental studies, capable of simultaneously controlling a number of variables, permit the simulation of diverse environmental regimes. A self-contained aquatic bioassay facility is available for testing toxic substances.

Large-scale fish behaviour studies can be performed in a 9000-sq-ft facility that includes a number of fish tanks ranging up to 50 ft in diameter. Also available are a 50-ft flume for studies on running water habitat and a Lab Wave tank. Temperature, light intensity and current can be controlled in all the experimental tanks.

Vegetation studies are performed in a 1000-sq-ft all-season greenhouse, which, coupled with a modern plant physiology laboratory, permits investigations of plant growth and movement of substances at both the organism and organ levels.

Uptake and movement of radionuclides through aquatic and terrestrial food-chains can be studied in our 1200-sq-ft low-level radiobiological research laboratory. Environmental chambers are available for fumigation-type studies. Modern microbiological laboratory facilities are also available.

Licenced animal holding facilities are used to maintain experimental stocks.

If you would like further information concerning our biological capabilities and facilities, or if you would like to discuss a biological problem of interest to your organization, please contact Dr. G.L. (Gian) Vascotto at (416) 231-4111, ext 6865.

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2.0 PROGRAM AREA 1 ..... UTILIZATION

Aquaculture - Giant Freshwater Prawn

Background

The Ontario Hydro Biology Section has been developing the technology for the giant freshwater prawn as a thermal aquaculture product since 1984. Successful transfer of a viable prawn aquaculture technology to private enterprise should lead to expanded markets for low grade heat available at Ontario Hydro generating facilities.

1987 Highlights

Major goals for 1987 were, modelling the effects of stocking density and size sorting on production, assessment of size-differentiation effects in post-larval prawns and to gather data under simulated commercial production conditions in greenhouse raceways. Results led to significant progress in technology development.

Preliminary models, using results of stocking density and size-sorting experiments, demonstrate strategies for the optimization of yield through the manipulation of prawn densities for various size classes, for example, small size classes can be raised at high densities to produce maximum biomass at the expense of survival. However, as animals move into larger size classes, and market value of individuals increases, lower densities must be used to maximize survival and yield.

Assessment of size-differentiation effects in post-larval prawns has demonstrated that the growth potential of individuals can be effectively predicted by the second month of post-larval development. This allows cutting of non-productive individuals early in the grow-out cycle maximizing marketable yield and simultaneously minimizing production costs.

During the third quarter of 1987 two 2 x 4 m greenhouse raceways were constructed at the Kipling Research complex. During the first sixteen weeks of 24-weeks of simulated commercial production, yields approached 6.5 tonnes per hectare.

Studies examining size-differentiation in post-larval prawns and simulated commercial greenhouse production will continue in 1988. The proportion of the heterogenous individual growth (HIG) phenomenon due to environmental and genetic factors will be defined by using prawns from a single brood of known parentage. Optimizing production in the greenhouse raceways will receive priority in anticipation of commercial interest in pilot project funding.

Additional areas of research and development are under consideration for 1988. Post-larval prawn production may be re-attempted using information gained at the 1988 World Mariculture Society Conference. Factors influencing the aggressive behaviour of sexually mature prawns in relation to various substrate designs may also be studied.

3.0 PROGRAM AREA 3 ..... TRANSMISSION SYSTEMS

Vegetation Control

Background

The goal of the vegetation control program is to identify more effective, efficient and environmentally responsible means of controlling undesirable vegetation on transmission and distribution rights-of-way. Past studies have explored novel concepts of vegetation control, attempted to improve on existing control techniques, provided environmental information and evaluated new products. Affects of tree cutting, population dynamics of the right-of-way vegetation and investigation of trunk injection of growth regulators were the main areas of investigation in 1987. The work in this area includes some anticipatory research as well as more applied work and consulting. Work to be discussed in the following section focuses on "control", see Program Area 9 for further related work.

1987 Highlights

Sprouting Response

The cutting of a hardwood tree usually stimulates dormant buds in the stump and root system to produce new shoots. Studies of this process have focused on the sprouting response of silver maple as a function of the month of cutting. A significant effect of the month of cutting on stump mortality was found. Cutting trees in June, July and August produced smaller sprouts and higher mortality. A long-term sprouting dynamics study of sugar maple, white ash, trembling aspen and black cherry indicates that the total number of sprouts has declined in each successive year. The response is species specific with sprouts of white ash declining by 47% between 1985 and 1987.

Two years after clearing a simulated right-of-way at the McCowan Road site, stems of stump sprouts were considerably taller than the usually more numerous tree stems originating from seeds. A group of shrub species was identified by ordination techniques to be negatively associated with incompatible tree species.

Growth Retardant

The trimming of trees under distribution lines is a major problem and expense which is repeated at intervals of four to eight years. New growth regulators are being studied which inhibit the biosynthesis of plant hormones (gibberellins) resulting in reduction of sprout growth without noticeable injury symptoms. MBR 18337, EL-500 (flurprimidol) and PP333 (paclobutrazol) were injected into silver maple. The injection into seedlings grown in the greenhouse resulted in inhibition of sprout growth and internode elongation and a reduction of the number of internodes formed per sprout. Less pronounced results were obtained when 12-year old silver maple trees were injected with EL-500 or PP333 in the field.

Work in these areas has been entirely funded by the Research Division.

4.0 PROGRAM AREA 5 ..... NUCLEAR GENERATION

Tritium and Other Radionuclides

Background

The radionuclide program focuses on determining the biological behaviour of tritium and other radionuclides released from Ontario Hydro's nuclear facilities. Projects in this area are quite diverse and include a large proportion of anticipatory and interdisciplinary work, usually undertaken with client support. Because some biotechnology - related work has been reported here, progress on some program 0 projects are also included.

In 1987, the main areas of investigation were:

- HT field release
- deuterated materials
- tritium recovery - hydrogenase
- biofouling
- biotechnology

1987 Highlights

HT Field Release

Tritium (T) a radioactive isotope of hydrogen (H) is produced by Candu reactors. It is presently believed that under many conditions, the major fraction of the dose arising from an airborne release of HT is a consequence of the conversion of HT to HTO (a form of tritiated water) in surface soils by the action of soil micro-organisms. The radio toxicity of HTO is about 10^4 higher than that of HT. Thus, if HTO is re-emitted or if it is incorporated into surface waters or vegetation, the dose from HTO will readily dominate that from the plume HT.

Extensive measurements of soil and foliage were made before, during and after a release of HT on June 10 at a Chalk River Nuclear Laboratory field site. Preliminary results indicate that upper soil (0 - 2 cm depth) and plant litter concentrations increased rapidly and declined over three days while concentrations in lower soils (2 - 7 cm and 7 - 22 cm) increased gradually over three days. Tissue free water tritium (TFWT) in foliage peaked and declined to near background by three days. Long-term (up to 121 days) calculations of the ratio of organically bound tritium to TFWT in plants at the site and potted plants exposed to the release are quite different ranging from less than unity to 16 due to temporal dependence. The dynamics between air, soil and tissue free water tritium support the concept that atmospheric HT is oxidized to HTO at the soil surface by microbes followed by evapotranspiration to the atmosphere.

This project involves anticipatory research as well as in-depth field work and analysis. Co-funding for this work is being provided by Canadian Fusion Fuels Technology Program.

Deuterated Materials

Synthetic organics such as lubricants produced from deuterated hydrocarbons have longer useful lifetimes than conventional counterparts because deuterated hydrocarbons have enhanced

oxidative stability. The biosynthesis of fully deuterated lipids from the green alga, Scenedesmus obliques is being performed and studied. The alga was adapted to grow in 100% heavy water medium, then cells were concentrated by a newly developed co-precipitation technique and fatty acids were recovered. This new process resulted in fatty acid yields comparable to a much more complex and time-consuming conventional procedure.

The production of deuterated materials is new product development funded by New Business Ventures.

Tritium Recovery - Hydrogenase

Ambient temperature catalysis of hydrogen conversion reactions would have a number of nuclear applications. Hydrogenase, which catalyses conversion reactions between elemental and oxide forms of hydrogen (deuterium and tritium), is produced by Alcaligenes eutrophus, a bacterium. A series of experiments have been done to investigate hydrogenase activity over the growth phase of this bacterium. The half saturation constant for hydrogenase occurs at about four times the normal concentration of H_2 in air. The functional activity of the enzyme does not appear to differ with culture age.

This work is anticipatory in nature and is being funded divisionally.

Biofouling

An interdisciplinary program has been established at OHRD to evaluate the causes of and remedies for corrosion failure in major heat exchangers. The use of untreated water in heat exchangers results in a slimey film of bacteria inside the water jackets that leads to reduced rates of flow, loss of heat exchange capacity and eventual corrosion failure of heat exchanger materials. Most approaches to control this problem have environmental consequences or interfere with station operations. While progress has been slow because of lack of microbiological expertise, microbiological examination of Incoloy tubes removed from the Pickering model heat exchanger rig at periodic intervals up to April, 1988 is ongoing.

This work is primarily problem solving in nature and is being funded by Technical and Training Services.

Biotechnology

A strategy document has been written identifying some potential areas of exploration and resources required to initiate work in this area. Biological means of cleaning coal, reducing wastes and producing new products are three potential areas for future work.

This work could range from providing a service to being anticipatory in nature. Central Thermal Services is funding a study of wastes. Divisional funding will be required to build resources in this area.

5.0 PROGRAM AREA 9 ..... ENVIRONMENT

Field Investigations, Fish Control, Special Studies

Background

Most of the Biological Research Section's activity addresses environmental concerns. The pre- and post-operational field investigations done for Design and Development involve major biological field sampling programs and consume over half the resources of the section. These studies are fully client funded and result in enormous amounts of data which can be as expected or can present surprises when it is analyzed. Field work in 1987 was done at Atikokan TGS, Bruce "B" NGS, Pickering "B" NGS, Mattagami River, Big Chute HGS and Mississagi River.

A well established program of fish control using behavioural techniques has resulted in the development of world leading innovations which are being transferred to other utilities and industry.

Special studies have also been done, including investigating the biological consequences of elimination of tempering at Nanticoke and summarizing the influence of industrialization on the aquatic environment near Nanticoke as well as a study of translocation of herbicides.

Virtually all the work in this area is client supported.

1987 Highlights

Field Investigations

Pickering "B NGS

A special investigation of round whitefish spawning continued. Substantial amounts of data on round whitefish was reported based on catches at Pickering and Darlington. Distinct stocks may be spawning at the two sites as indicated by differing age structures and electrophoretic analysis. A temperature rise averaging 3°C caused whitefish eggs at Pickering to hatch four to five weeks ahead of those at Darlington. A predictive computer simulation of hatch dates agreed with observations.

Monthly fish surveys were done as part of year II of the post-operational study. A study of residency of fish in the discharge conducted from February through July 1987 was hampered by high turbidity and poor visibility during the winter months. Carp, smallmouth and white bass, white perch, freshwater drum, and walleye were among the more common species observed. In the last week of March, only gizzard shad were taken in a net in the "B" discharge. Smallmouth bass were tagged and released in both "A" and "B" discharges to try to determine residency. Radiotelemetry and tag returns from lake trout tagged in the fall of 1986 suggest that lake trout move throughout Lake Ontario and show no particular affinity for the Pickering site. In addition to the regular fishing and tagging, sediment samples were collected in August and September for gamma radionuclides, particle size and organic content analysis.

This project, funded by Environmental Studies and Assessments of Design and Development, will continue.

Darlington NGS

Round whitefish incubation studies similar to those at Pickering indicated higher egg survival than at Pickering until the April sampling. A progressive increase in sediment levels appeared to be the cause of a drop from 50% to less than 20% in average egg survival.

The year I commissioning study has been underway since January, 1987. Several long-term study components begun during the 1984/86 pre-operational period have been continued.

- gill net sampling of adult and juvenile fish
- spring sampling for larval round whitefish
- sediment movement monitoring
- sedimentation rate and radiological analysis
- assessment of predation by pelagic fish on benthic organisms

New study components include:

- a field incubation study with round whitefish eggs
- test of larval drift nets for round whitefish larvae
- assessment of the effectiveness of the precast porous bottom cooling water intake in reducing fish entrapment
- trap net investigation of lake whitefish spawning

This project, funded by Environmental Studies and Assessments of Design and Development, is continuing.

Atikokan TGS

The results of the commissioning study (1985) were reported. Physical and chemical parameters in the Atikokan cooling circuit were generally similar to those of previous years. One exception was Moose Lake where the thermocline was drawn below the level of the station's intake. The relative and actual abundance of walleye and several forage fish species varied somewhat from previous years, however further sampling is required to verify trends.

The second year of post-operational studies was initiated in April. There was a large run of walleye at the outflow from Snow Lake to Icy Lake. A beaver dam has been constructed at the outflow of Ski Lake into Icy Lake virtually eliminating flow. As a result little spawning occurred in this area. Analysis of drift net samples and larval fish tows suggests that spawning of walleye and white sucker resident in Icy Lake may be advanced by more than a month due to the influence of the thermal discharge. This possibility will be further examined during 1988.

This project, which is funded by Environmental Studies and Assessments of Design and Development, will continue.

Bruce "B" NGS

The results of the pre-operational study conducted from 1979 to 1983 were summarized. Baseline data were acquired for a wide range of physical, chemical and biological characteristics with major emphasis on fish populations. Wind induced disturbances and currents due to the exposed nature of the shoreline influenced temperature, substrate, sedimentation, transparency, density as

well as composition of benthic flora and fauna and larval fish. The most abundant fish were alewife, rainbow smelt, spottail shiner, longnose sucker and white sucker. Their distribution was generally consistent with previously reported life history characteristics.

The year I post-operational study focused on special studies of smallmouth bass reproduction and recruitment. Preliminary data suggest that smallmouth bass reproduction in the Bruce "B" NGS discharge was more successful than that in the Bruce "A" NGS and may have contributed substantially to recruitment of young-of-the-year to the local population. The catch of walleye continues to increase although as yet young walleye have not been captured.

This project, funded by Environmental Studies and Assessments of Design and Development, will continue.

Mattagami River

Surveys have been conducted at Mattagami since 1986 to collect data for an environmental assessment report. In 1987 winter water chemical and physical conditions were monitored. In addition Adam Creek was fished in March and August as a follow-up of a fish tagging program conducted in 1986. Future studies will focus on walleye and sturgeon spawning in Adam Creek and movement of sturgeon through the spillway.

This project, funded by Environmental Studies and Assessments of Design and Development, will continue.

Big Chute HGS

The potential effects of a proposed expansion of Big Chute HGS are being assessed. In particular, modelling of Six Mile Lake will be done to assess whether a change in direction and volume of inflow will change fisheries habitats or chemical constituents. A detailed sampling protocol has been developed in close cooperation with the client.

This project, funded by Environmental Studies and Assessments of Design and Development, is continuing.

Mississagi River

Water quality, fish spawning habitat and fish species distribution below Red Rock GS on the Mississagi River were monitored in 1987 as the final year of a study to determine the effect of bank stabilization on the aquatic environment. Banks were stabilized with quarried stone between 1983 and 1985. Water quality deteriorated near the construction site but after construction was completed water quality improved. A spawning bed downstream was not seriously impacted by changes in substrate. Fewer fish were collected during both day and night in 1987 but the yearly variation in fish numbers was not significant. It appears that the placement of quarried stone did not have a major impact on the aquatic environment.

This work was funded by Environmental Studies and Assessments of Design and Development and is complete.

Fish Control

Behavioural Methods of Fish Control

The Biological Research Section has been active in the area of fish control for about a decade attempting to develop technology to reduce impingement of fish in once-through-cooling systems at Ontario Hydro generating stations. The development of behavioural methods of fish control looks very promising, however different fish species can exhibit different behaviours and the local conditions may have a significant impact on fish behaviour.

During 1987, effort has been focused on the lab and field evaluation of the fish "hammer", a patented acoustical device producing a high amplitude impulsive sound.

A semi-anechoic tank was used to test the response of juvenile white perch to sound. About 13,500 fish from the Hudson River were repelled at specific frequencies and amplitudes and did not show strong habituation over a 2-hour period. This project was funded by New York Power Authority.

Another lab study, funded by Environment Studies and Assessments tested sturgeon's response to sound. It was concluded that because the sturgeon's auditory system is quite primitive this species is not responsive to this behavioural control.

Utility projects on fish control were participated in through EPRI, the CEA, and the Norwegian Power Group (Vassdragsregulantenes Forening). EPRI has developed a multi-year program to evaluate technologies for controlling downstream movement of fish at hydroelectric facilities. Seven "hammers" are being leased to EPRI at cost for evaluation at the Ludington Facility in Michigan and the Holyoke site in Massachusetts.

A laboratory study was also funded by EPRI on the responses of several fish species to sound. Results are being analyzed.

The CEA study had a similar objective, to guide migrating fish at the Seton facility in British Columbia and the Rivere-des-Prairies facility in Quebec. Strobe lights, air bubbles, pneumatic poppers and "hammers" were tested. At Seton the "hammer" had the greatest effectiveness while at Riviere-des-Prairies there was a poor fish run and results were inconclusive.

The Norwegian study mentioned above, had as an objective the evaluation of the responses of Atlantic salmon to sound. Preliminary results suggest that these fish did not show a marked avoidance of the "hammer". It was suspected that fish were preconditioned to sound at the hatchery where they were purchased.

Contract work with New Business Ventures has produced a range of experience using fish control technologies in the field. This work is summarized in the following table:

Location	Client	Preliminary Results
Annapolis Tidal Power I & II	Nova Scotia Power Corp	Adult fish slight attraction to filtered mercury vapour light
		Adult fish repelled by "hammer"
Hell's Gate	Nova Scotia Power Corp	Fish deterred from passing through the turbine
Albany GS, NY Hudson River, I&II	ESEERCO Niagara Mohawk	Too few fish to evaluate
Cleveland, OH Cuyahoga River	LTV Steel	Few fish to date
Trenton GS	Nova Scotia Power Corp	Few fish to date

Several other contracts are in the negotiation stage. This area has moved through its cycle to the stage that a service can be provided. The majority of the work in 1987 has been client funded.

Special Studies

Effects of Industrialization

An integrated analysis of physical, chemical and biological data collected under the auspices of the Nanticoke Environmental Committee (NEC) from 1969 to 1983 and an evaluation of the effects of industrialization (an oil refinery, steel mill and thermal generating station) on the Nanticoke area of Long Point Bay was completed and favourably received by a review panel of research scientists from the University of Toronto. Formal release of the report is expected in 1988.

This work has been funded by NEC (Stelco, Texaco, MNR, MOE and Ontario Hydro).

Translocation of Growth Regulator

The objective of this new project is to determine how much of the growth regulator XE1019 injected into the stems of four-year old silver maple saplings is translocated to the foliage. Growth regulator and growth regulator metabolites present in the foliage of trees in the fall could enter the soil and/or groundwater in the immediate vicinity of the trees after degradation of the leaf litter. Samples of foliage from trees injected with 3.5 μCi of ^{14}C-XE1019 (donated by Chevron Chemical Co) were collected at various times and analyzed.

This work is being funded by the Research Division.

6.0 1988 PLANS

The range of activities undertaken in 1987 and planned for 1988 have been discussed. A summary of the financial picture is given in the following table. In 1987, less work was done on divisional funds in the nuclear area, while more was done in the environmental area in response to corporate clients. In 1988 the planned budget reflects the discussion in the previous section.

While no radical changes are planned for 1988, some work areas will increase in the level of effort provided, some will decrease and others will continue to receive similar attention to what they received in the past.

Work based on divisional funding will increase slightly to 38% in 1988 from 31% in 1987 and 33% in 1986. Corporate clients will continue to fund more than half the work of the section and external contracts will continue at a low level. Utilization will receive slightly less funding in 1988 while Transmission Systems and and Nuclear Generation will remain almost constant. Environmental work will receive a greater share of divisional funds.

In program area 1, studies examining size-differentiation in post-larval prawns and simulated commercial greenhouse production will continue in 1988. Optimizing production will receive priority in anticipation of commercial interest in pilot project funding.

Program area 3 will continue to be active. Sprouting characteristics and performance of growth regulators will be studied. More emphasis will be placed on population dynamics of the right-of-way.

Program area 5 will see decreased activity in the tritium area as field release studies are completed. Effort on deuterated materials is expected to increase. Hydrogenase production studies will continue at about the same level of effort, as will the biofouling work. Work in the biotechnology area will increase. Of the areas identified as having potential for applications of interest to Ontario Hydro, the area of waste clean-up seems to have aroused the most interest. This area will be further pursued under Program Area 9.

Program area 9 will see some re-emphasis of work. Major site specific studies will continue at about the same level of effort as in 1987. Work on fish deterrents will decrease although a number of external contracts will be pursued as well as installation of "hammers" at Thunder Bay. Sound as an attractant will be studied. In addition, effort will be placed on using remote sensing techniques to identify fish. Nitrogen cycling in the ecosystem will be studied in cooperation with Atmospheric Research. Projects related to hydraulic generation impacts will be initiated. The effects of low levels of electromagnetic radiation will be studied. Impact of legislation such as MISA will be studied.

In real terms, the level of effort of the Section and the headcount is planned to grow minimally from 1987.

Table 1: Sources of Funds (Per Cent of Total) in 1986, 1987 and 1988

Program Area		External Clients		Corporate Clients		Divisional Funds		Total*	
		Actual	Projected	Actual	Projected	Actual	Projected	Actual	Projected
General	86	0		2		3		5	
	87	0	0	0	0	0	0	0	0
	88		0		0		0		0
Utilization & Conservation	86	0		0		6		6	
	87	0	0	0	0	7	5	7	5
	88		0		0		4		4
Transmission	86	0		0		7		7	
	87	0	0	0	0	11	9	11	9
	88		0		0		10		10
Distribution	86	0		0		1			
	87	0	0	0	0	0	0	0	0
	88		0		0		0		0
Nuclear	86	0		0		4		4	
	87	0	0	4	3	11	6	15	9
	88		0		3		7		10
Environmental	86	3		52		9		74	
	87	6	5	50	61	10	9	66	75
	88		6		54		16		76
General Technical	86	0		0		3		3	
	87	0	0	0	0	1	2	1	2
	88		0		0		1		1
Total*	86	13		54		33			
	87	6	5	54	64	40	31		
	88		6		57		38		

*may not add up due to rounding

Appendix A

BIOLOGICAL RESEARCH SECTION ORGANIZATION CHART

Supervising Biologist

Mr. G.T. Haymes (Acting, Jan - Jul)
Dr. F.S. Spencer (Acting, Aug - Sept)
Dr. A.C. McMillan

Section Secretary

Ms. R. Ayoung

Section Assistant

Ms. R.A. Nakrosius

Unit Head - Aquatic Surveys & Program

Mr. G.T. Haymes
Dr. J.S. Griffiths
(Acting, Jan - Jul)

Researchers

Mr. H. Balesic
Dr. J.S. Griffiths
Ms. J.K. Kwik

Mr. R. Sheehan

Technical Staff

Mr. T. Brown*
Mr. E. Checko
Mr. J. Harcus
Mr. L. King
Mr. D. Lowther

Program Leaders

Dr. G.P. Arron
(Vegetation Control)

Dr. P.H. Patrick
(Impingement)

Dr. F.S. Spencer
(Radiobiology)

Researchers

Dr. D.G. Brown
Mr. T.G. Dunstall
Mr. R.S. McKinley
Dr. D.W. Rodgers

Supervising Technician

Mr. D.J. Parker

Mr. P. Niklas
(Laboratory Support)

Ms. I. Cord
Mr. S. Poulton
Mr. B. Sim
Ms. L. Vereecken-Sheehan

Mr. H. Kowalyk
(Identification Support)

Ms. L. Bremner
Mr. F. Stubbs
Ms. C. Thomson**

* On Contract
** Left Section in 1987

Appendix B

List of Reports Issued During 1987

1. Ontario Hydro Research Division Report No 87-14-K. G.P. Arron. "Sprout Growth in Silver Maple Cut at Different Times of the Year". File No 834.1. February 20, 1987.

2. Ontario Hydro Research Division Report No CB87-5-K. G.P. Arron. "Herbicide Content of Water Samples Collected in 1987 Near the Herbicide Study Area, Wesleyville, GS". File No 834.1. November 16, 1987.

3. Ontario Hydro Research Division Report No 87-148-K. G.P. Arron. "Effects of Growth Regulators on the Number and Length of Internodes in Sprouts Formed on Trimmed Silver Maple. G.P. Arron". File No 834.1. June 24, 1987.

4. Ontario Hydro Research Division Report No 87-49-K. G.P. Arron. "Distribution of 2,4-D and Picoloram Residues in Environmental Components Adjacent to a Treated Right-of-Way". R.S. McKinley and G.P. Arron. File No 834.1. March 6, 1987.

5. Ontario Hydro Research Division Report No CB87-3-K. G.P. Arron. "Report on Annual Meeting of the Plant Growth Regulator Society of America (PGRSA) August 2 - 6, 1987 - Honolulu, Hawaii". File No 834.1. August 28, 1987.

6. Ontario Hydro Research Division Report C86-85-K. D. Brown. "Progress Report: McCowan Road Right-of-Way Study: Stump Sprouting and Suckering in the Second Growing Season". File No 834.1. February 13, 1987.

7. Ontario Hydro Research Division Report 87-113-K. D. Brown. "McCowan Road Vegetation Study: The Development of Wood Vegetation in the Second Year Post-Clearing". File No. 834.1. July 3, 1987.

8. Ontario Hydro Research Division Report CB87-8-K. D. Brown. "Progress Report: McCowan Road Right-of-Way Study: Stump Sprouting and Suckering in the Third Growing Season Following Cutting". File No. 834.1. December 1, 1987.

9. Ontario Hydro Research Division Report CB87-6-K. D. Brown. "Report on the Fourth Symposium on Environmental Concerns in Rights-of-Ways Management, October 25 - 28, Indianapolis, Indiana". File No 834.1. November 23, 1987.

10. Ontario Hydro Research Division Report No C87-52-K. T.G. Dunstall. "Attendance of the Ninth Symposium on Biotechnology for Fuels and Chemicals". File No 830.5. June 25, 1987.

11. Ontario Hydro Research Division Report No CB87-4-K. T.G. Dunstall. "Visit to Martek Corporation (Columbia, Maryland)". File No 837.8. September 23, 1987.

12. Ontario Hydro Research Division Report No C87-114-K. T.G. Dunstall. "Research and Development Opportunities in Biotechnology". File No 830.11. January 6, 1988.

13. Ontario Hydro Research Division Report No 87-82-K. J.S. Griffiths. "Darlington NGS Pre-operational Aquatic Study - 1984". File 837.321 DAR. March 20, 1987.

14. Ontario Hydro Research Division Report No 86-290-K. J.S. Griffiths. "Simulation Studies of Potential Effects form Atikokan TGS on Walleye Eggs". File No 837.321 ATI. February 17, 1987.

15. Ontario Hydro Research Division Report No 87-181-K. J.S. Griffiths. "Pickering NGS "B" Interim Aquatic Study: Round Whitefish Spawning Investigations - 1984/85". File No. 837.321. August 4, 1987.

16. Ontario Hydro Research Division Report No 87-88-K. G.T. Haymes. "Biological Research Section, 1987 Annual Report". File 830.5. March 25, 1987.

17. Ontario Hydro Research Division Report No 87-233-K. G.T. Haymes and J.K. Kwik. "Atikokan TGS Aquatic Studies August and October 1985". File 837.321 ATI. October 19, 1987.

18. Ontario Hydro Research Division Report No 87-174-K. L.P. King and R.W. Sheehan. "Bruce GS "B" Dump Site Study 1982 Results and Summary Report for 1977 - 1985". File No 837.321 BRU. July 13, 1987.

19. Ontario Hydro Research Division Report No 87-31-K. J.K. Kwik. "The Effect of Substrate on the Survival and Growth of Prawns". File No 836.4. March 6, 1987.

20. Ontario Hydro Research Division Report No 87-149-K. J.K. Kwik and L.P. King. "Pickering NGS "B" Interim Aquatic Study, 1984 and 1985". File No 837.321 PIC. June 25, 1987.

21. Ontario Hydro Research Division Report No 87-91-K. J.K. Kwik and P.U. Niklas. "Effect of Ration Size on the Growth and Food Conversion of Macrobrachium rosenbergii". File No 836.4. May 13, 1987.

22. Ontario Hydro Research Division Report No CB87-2-K. J.K. Kwik and H. Balesic. "Bruce Energy Centre, Water Quality Study, 1986 - 1987". File No 837.321 BRU. July 22, 1987.

23. Ontario Hydro Research Division Report No 87-49-K. R.S. McKinley and G.P. Arron. "Distribution of 2,4-D Picloram Residues in Environmental Components Adjacent to a Treated Right-of-Way". File No 834.1. March 6, 1987.

24. Ontario Hydro Research Division Report No CB87-1-K. R.S. McKinley. "Distribution and Abundance of Gamma Emitting Radionuclides in Western Lake Ontario Sediments". File No 837.88. April 6, 1987.

25. Ontario Hydro Research Division Report No 87-117-K. P.H. Patrick and R.S. McKinley. "Effectiveness of a Sonic Device in Repelling Adult Alewife at the Pickering NGS". File No. 837.315. June 12, 1987.

26. Ontario Hydro Research Division Report No 87-7-K. D.W. Rodgers. "Displacement of Larval Fish by Bruce NGS "A" Discharge". File No 837.315. February 9, 1987.

27. Ontario Hydro Research Division Report No 87-183-K. R.W. Sheehan. "Bruce GS 'B' Commissioning Biological Study Terrestrial Program Year in January to November 1984". File No 837.321 BRU. September 21, 1987.

28. Ontario Hydro Research Division Report No 87-171-K. R.W. Sheehan. "Mississagi River Bank Stabilization program Aquatic Monitoring 1985". File No 837.321. July 24, 1987.

29. Ontario Hydro Research Division Report No 87-189-K. R.W. Sheehan. "Fish Handling Pilot Study Pickering NGS and Nanticoke TGS". File No 837.315. July 24, 1987.

30. Ontario Hydro Research Division Report No 87-183-K. R.W. Sheehan. "Bruce GS 'B' Commissioning Biological Study Terrestrial program Year I January to November 1984". File 837.321 BRU. September 21, 1987.

31. Ontario Hydro Research Division Report No C87-6-K. F.S. Spencer. "Trip Report: French Environmental Tritium Behaviour Experiments Preliminary Results - November 26 - 27, 1986". File No 837.8. February 20, 1987.

32. Ontario Hydro Research Division Report No 87-136-K. G.L. Vascotto. "Distribution Patterns of Macrobrachium rosenbergii Relative to the Presence of Cover Strips". File No 836.4. May 27, 1987.

External Reports

33. "Behavioural Systems to Guide or Direct Fish at Hydro-electric Facilities - Phase 2 Field Evaluations - CEA 513 G543". P.H. Patrick and R.S. McKinley. August 1987.

34. "Field Studies of HT Oxidation and Dispersion in the Environment 1 - The 1986 August Experiment at Chalk River". CFTP Report G-87004. (Brown/Ogram/Spencer).

Appendix C

Publications Issued During 1987

1. Arron, G.P. and Camacho, F. "Reduction of the Number of Internodes and Internode Length in Sprouts Formed in Silver Ample Injected with Flurprimidol, Paclobutrazol or MBR 18337" in Proceedings for the XIVth Annual Plant Growth Regulator Society of America Meeting 1987, p288 - 294.

2. Brown, D. "Growth of Stump Sprouts on a Simulated Right-of-Way". In: W.R. Byrnes and H.A. Holt. Proceeding of the Fourth Symposium on Environmental Concerns in Rights-of-Way Management. On Press.

3. Patrick, P.H., McKinley, R.S., Christie, A.E., (Ontario Hydro) and Holsapple, J.G., New York Power Pool. "Fish Protection: Sonic Deterrents". Proceedings Workshop on Fish Protection at at Steam and Hydro Power Plants. San Francisco, California. October 28 - 30, 1987.

4. Patrick, P.H. and McKinley, R.S., and Micheletti, W.C. "Field Testing of Behavioural Barriers for Cooling Water Intake Structures - Test Site 1 Pickering Nuclear Generating Station". Proceedings Workshop on Fish Protection at Steam and Hydro Power Plants. San Francisco, California. October 28 - 30, 1987.

5. McKinley, R.S. and Patrick, P.H. "Behavioural Systems to Guide or Divert Fish at Hydroelectric Facilities - Phase 2 Field Evaluations". Proceedings Workshop on Fish Protection at Steam and Hydro Power Plants. San Francisco, California. October 28 - 30, 1987.

6. McKinley, R.S. and Patrick, P.H. and Mussali, Y. "Influence of Three Sonic Devices on Fish Behaviour". Proceedings Workshop on Water Power. Portland, Oregon, August 19 - 21, 1987.

7. Patrick, P.H. and McKinley, R.S. "Field Evaluation of Hidrostal Pump for Live Transfer of American Eels (Lab and Field Results)". Proceedings Workshop CEA Hydraulic Power Section. Niagara Falls, Ontario. September 9 - 11, 1987.

8. Patrick, P.H., Hester, R.A., Wiancko, R. and Christie, A.E. "Fish Impingement at Ontario Hydro's Generating Stations". Proceedings Workshop on Mechanisms of Compensatory Response of Fish Populations, Arlie, Virginia. EPRI EA-5200, May 1987.

9. Rodgers, D.W., Watson, T.A., Langan, J.S. and Wheaton, T.J. "Effects of pH and Feeding Regime of Methylmercury Accumulation within Aquatic Microcosms". Environmental Pollution 0269 - 7491/87.

Appendix D

List of Conference Presentations Given 1987

1. Patrick, P.H., "Fish Control at Annapolis Tidal GS (Nova Scotia)". Technical Meeting, Halifax, Nova Scotia, July 1987.

2. Brown, D., Arron, G.P., "The Sprouting of Dynamics of Five Hardwood Species in the First Two Years Following Clearcutting". Canadian Journal of Forestry. July 1987.

3. Patrick, P.H., "Fish Control - Hydroelectric Applications". Norwegian Delegation. July 1987.

4. Patrick, P.H., McKinley, R.S., "Field Evaluation of a Hidrostat Pump for Live Transfer of American Eels at a Hydroelectric Facility". North American Journal Fish Management, 7: 303-305. August 1987.

5. Arron, G.P., Camacho, F., "Reduction of the Number of Internodes and Internode Length in Sprouts Formed in Silver Maple Injected with Flurprimidol, Paclobutrazol or MBR 18337". Annual Meeting of Plant Growth Regulator Society of America, Honolulu, Hawaii. August 1987.

6. Patrick, P.H., McKinley, R.S., "Fish Control-Sonic Systems". Water Power, Portland, Oregon. August 1987.

7. McKinley, R.S., Patrick, P.H., Mussali, Y., "Influence on Three Sonic Devices on Fish Behaviour". Water Power, Portland, Oregon. August 1987.

8. Patrick, P.H., "Effectiveness of a Hidrostat Pump in the Live Transfer of American Eels". CEA Hydraulic Conference, Niagara Falls. September 1987.

9. Patrick, P.H., McKinley, R.S., "Fish Protection: Sonic Deterrents". EPRI Conference on Fish Protection. October 1987.

10. Patrick, P.H., McKinley, R.S., "Use of Behavioural Stimuli to Divert Sockeye Salmon Smelts at the Seton Hydroelectric Station, BC". EPRI Conference on Fish. October 1987.